HIGH SPEED RAIL

BENEFITS THAT ADD UP

A report for the Australian Greens

Foreword

Imagine getting on a train in the centre of Melbourne and arriving in the centre of Sydney just three hours later. Along the way you will have access to the internet, can use your mobile phone, move freely around the carriages and dine in a restaurant or café.

Regional towns on the outskirts of our great cities will be less than an hour away, transforming their role as economic centres.

Imagine a mass transit long distance transportation system that can be powered by clean and renewable energy and that reduces the impact of pollution and car travel on our cities and country.

This is the promise of high speed rail and after many decades of discussion and delay the time for high speed rail has finally arrived.

The Agreement that the Greens made to support the Gillard minority government included a commitment to conduct a study into high speed rail. The first phase of the study has been completed and the second phase report will be released before the end of the year. It will include options on the financial mechanisms for making high speed rail a reality.

This report is an important precursor to that second phase study because while there has been much discussion of the financial costs of high speed rail, there has been little discussion about the financial benefits. The report shows that over 30 years the benefits make up over half the cost of high speed rail. The report examines some of those benefits and highlights the financial advantages that will come when we catch up with the rest of the world and invest in the future of transportation in the 21st century.

Adam Bandt MP
Deputy Leader, Australian Greens
Member for Melbourne

The Author

Naomi Edwards is a highly regarded member of the environmental investing community. She has served on the Boards of Australia's two largest dedicated ESG investing firms (Australian Ethical Investment and Hunter Hall Ltd) and is currently Chairman of an industry super fund. She has extensive training in, and has written papers on, economics, investments and the financial aspects of environmental issues. Naomi has a first class honours degree in mathematics from the University of Canterbury and is a Fellow of the Institute of Actuaries (London) as well as a Fellow of the Australian and New Zealand Institutes of Actuaries. She is a former partner of Deloitte, and of Trowbridge Consulting. She is well respected in both the environmental and the investment communities. Naomi has applied this experience to a consideration of the many published papers on the impacts of High Speed Rail. Email: naomiedwardsactuary@gmail.com.

Contents

Executive Summary

High speed rail ("HSR") now exists on every continent except for Australia and Antarctica. There is a great deal of international experience and analysis available to assess the likely costs and benefits of HSR.

As with all nation-building infrastructure projects, the costs of HSR are more straightforward to assess than the benefits. This is because the costs tend to be monetised and straightforward, whereas the benefits are mostly externalised and spread across the broader economy. Costs are incurred up front, whereas the benefits accrue over decades. This is certainly the case with HSR.

This report has identified some **$48 billion** of benefits from HSR, including direct user benefits and also externalities to society.

The Phase 1 Report into high speed rail (HSR), published by the Australian Government in 2011, quantified the likely costs to build a HSR on Australia's east coast, at about $80 billion. The benefits of HSR will be quantified in the Phase 2 Report, due to be completed this year.

The benefits, once quantified, are significant. They include both direct benefits to HSR users and operators (i.e. through time savings and profits, respectively) and indirect benefits to society (called externalities). The main externalities include fewer accidents, lower greenhouse gas emissions, less air and noise pollution, less congestion on roads and at airports and substantial time savings to users. There are significant benefits to regional Australia in towns where the HSR passes through, agglomeration benefits and benefits to cities with a HSR station. Agglomeration and regional rebalancing benefits are not quantified in this report, although they have been in some other recent reports.

This report places indicative values on the externality and user benefits.

Some benefits of HSR, valued over thirty years of operation

Quantified Benefits	
$31 billion	Time savings
$2 billion	Greenhouse gas savings
$11 billion	Congestion savings
$4 billion	Accident savings
$64 million	Pollution savings
$48.064 billion	**Total Benefits**
Unquantified Benefits	Agglomeration and Regional rebalancing
	Operator Benefits

The direct user benefits and the externality benefits make up over half of the forecast cost to build HSR.

HSR lowers greenhouse gas (GHG) emissions because it substitutes for flying (primarily) and driving. Even running on electricity that is mostly generated by coal fired power stations, HSR produces much lower GHG emissions than flying or driving. In its first year of operation (2036), HSR is expected to reduce net GHG emissions by some 1.3 million tonnes of CO_2 emissions, of which about 1.1 million tonnes relates to avoided airplane flights and 0.2 million tonnes relates to avoided car

journeys. That's the equivalent of taking 365,000 cars off the road. This has a value of $140 million per annum (in 2011 dollars) in the first year of full HSR, valued at $2.2 billion over thirty years. Pollution savings arise because of lower noise and atmospheric pollutions from HSR because it is electric rather than powered by diesel or petrol, like cars, buses and conventional trains. Avoided pollution is valued at about $4 million per annum.

HSR delivers time savings to Australians who can switch from 2 or 3 hour car trips to 50 minute HSR trips as part of a comfortable daily commute. Those travelling longer distances to regional areas make much larger time savings, as well as travelling with more productivity and comfort. HSR trains are generally equipped with internet access, meeting coaches and spacious seating. These time savings have been valued at $1.34 billion per annum in 2011 dollars or $31 billion over the first 30 years of operation of HSR.

HSR delivers congestion savings to roads and airports. As a result of HSR, some 3.6 billion passenger kilometres will be diverted from car trips to trains. This will lead to a decongestion benefit on roads near the HSR. This has been valued at $66 million per annum or 1.1 billion over thirty years. In regard to airport decongestion, it is a major assumption of this report that HSR would be able to defer or even mitigate the need for a second airport in Sydney. The congestion benefit has therefore been taken as the $10 billion that it would cost to build a second Sydney airport.

HSR lowers accident costs. The value of the saving to Australia in respect of lower car accident costs due to HSR is in the order of $4.2 billion over the first 30 years of HSR (about $260 million per annum). The saving arises because accident costs from HSR are about one fiftieth that of car driving. Even a small reduction in the number of cars on the road has a very big saving in terms of medical and lost productivity impacts.

The benefits of HSR to a rapidly growing city like Melbourne are many. HSR is expected to substitute for some 15 million trips by other modes in its first full year of operation. With travel times of 50 minutes to places like Shepparton or 65 minutes to Albury-Wodonga, the pressure on Melbourne's outer suburbs, rental market and housing affordability will be eased. Living in regional Victoria or, indeed, regional NSW, and commuting to Melbourne for work will be feasible, reliable and enjoyable.

In regard to regional Australia, HSR has been shown overseas to contribute to regional rebalancing in areas close to HSR stations, meaning the inequalities between cities and regions are lessened. This can be understood by considering, for example, the impact that HSR will have in passing through the towns of Shepparton, Albury-Wodonga and Wagga Wagga on its way from Melbourne to Canberra. These towns are expected to have over 1 million new tourist and commuter visits each year as a result of HSR. All of these regional towns have poorer socio-economic scores than nearby capital cities, despite having have quality universities, hospitals and businesses located there. They also have much lower rents and house prices than Melbourne and Canberra. HSR will bring new families to these towns, initially people who commute to jobs in Melbourne and Canberra. Longer term this will contribute to strengthening local universities, hospitals and businesses.

This report has identified some $48 billion of benefits from HSR, including direct user benefits and also externalities to society. There are other benefits from HSR that are beyond the scope of this report, including:

1. Operator benefits – this is the net profit that operators of the HSR will make from the surplus of user charges over costs. However offsetting this, is a loss of net revenues to operators of other transport modes which HSR would substitute for.

2. Agglomeration benefits – this is the economic and social benefit from reducing effective distances between firms, individuals and communities. A report commissioned for the ARA has estimated these benefits at some $4 billion per annum.

There are also certain direct and indirect costs involved with HSR that are not addressed in this report or quantified in the Phase 1 Report, including a potential reduction in fuel excise duty to the government because of lower fuel consumption by road vehicles and aircraft.

As a nation-building project, HSR will position Australia well for the population growth being forecast by the ABS, as well as for a carbon constrained world. This report shows that the direct user benefits and the externality benefits make up over half of the forecast cost to build HSR.

1. Scope of this report: Benefits of HSR

High speed rail ("HSR") now exists on every continent except for Australia and Antarctica. This means that there is a great deal of international experience and analysis available to assess the likely costs and benefits of HSR.

As with all nation-building infrastructure projects, the costs of HSR are more straightforward to assess than the benefits. This is because the costs tend to be monetised and straightforward, whereas the benefits are mostly externalised and spread across the broader economy. Costs are incurred up front, whereas the benefits accrue over decades. This is certainly the case with HSR.

> *Externality costs*
> An externality rate is an estimate of the cost to society of events such as car accidents which is not normally monetised. In a transport context, for example, negative externalities could include air and noise pollution from vehicles which affect people living near roads and car accidents. Those affected by air and noise pollution receive no compensation from the cars that create the pollution. A person who suffers paralysis as a result of a car accident bears a tremendous cost that is generally not met by the parties to the accident.

Previous research

In July 2011 the Government published its *Phase 1 Report into High Speed Rail* (AECOM, 2011). Phase 1 focused on identifying preferred routes, assessing the likely range of costs for those routes and estimating the potential future market demand for HSR. Phase 1 estimated that the cost of building the HSR was in the order of $80 billion in 2011 dollars, with a range estimate from $60 billion to $110 billion. To put this cost in context, in 2009-10, Australia spent some $15.8 billion on road construction (BITRE, Australian Infrastructure Statistics Yearbook 2011, 2011), so that a HSR would cost about five years of annual road construction spending.

The Phase 1 Report did not explicitly examine the financial feasibility of HSR on the east coast of Australia and did not include a benefit versus cost analysis. The benefits were described, but quantified on a relative base only, comparing benefits under alternative corridor routes, rather than on an absolute basis. For example, running the HSR through Wagga Wagga, rather than Shepparton, was estimated to increase HSR externality benefits by some $900 million, but the base value of externality benefits (to which the $900 million should be added) was not published in the report. While Phase 1 discussed the potential social and regional development impacts of a HSR network, it did not publish the value of the benefits. In addition, certain benefits such as a reduction in air congestion in and out of Sydney airport, and agglomeration benefits, were not discussed at all.

The Phase 2 Report (due end 2012) will examine the financial feasibility of HSR, identify an optimum route alignment, refine patronage and cost estimates and investigate potential financing options.

In June 2012 the Australasian Rail Association ("the ARA") released a report examining the wider social and economic implications of HSR (Hensher, 2012). The report looked only at benefits arising from the Melbourne to Sydney route and it used an estimate of agglomeration[1] benefits to quantify social and economic implications.

[1] Agglomeration is the term for what happens when people and industries have more opportunities and access to connections (social or work), because effective distances between them are 'reduced'.

This Report

This report – *High Speed Rail – The Benefits Add Up* uses the analysis contained in the Phase 1 Report to expand on some of the environmental and social benefits that would arise if Australia had a HSR on its east coast. It combines this analysis with the agglomeration benefits described in the ARA report to provide some greater insight into certain benefits of HSR.

Table 1 Published quantification of HSR costs and benefits in recent reports

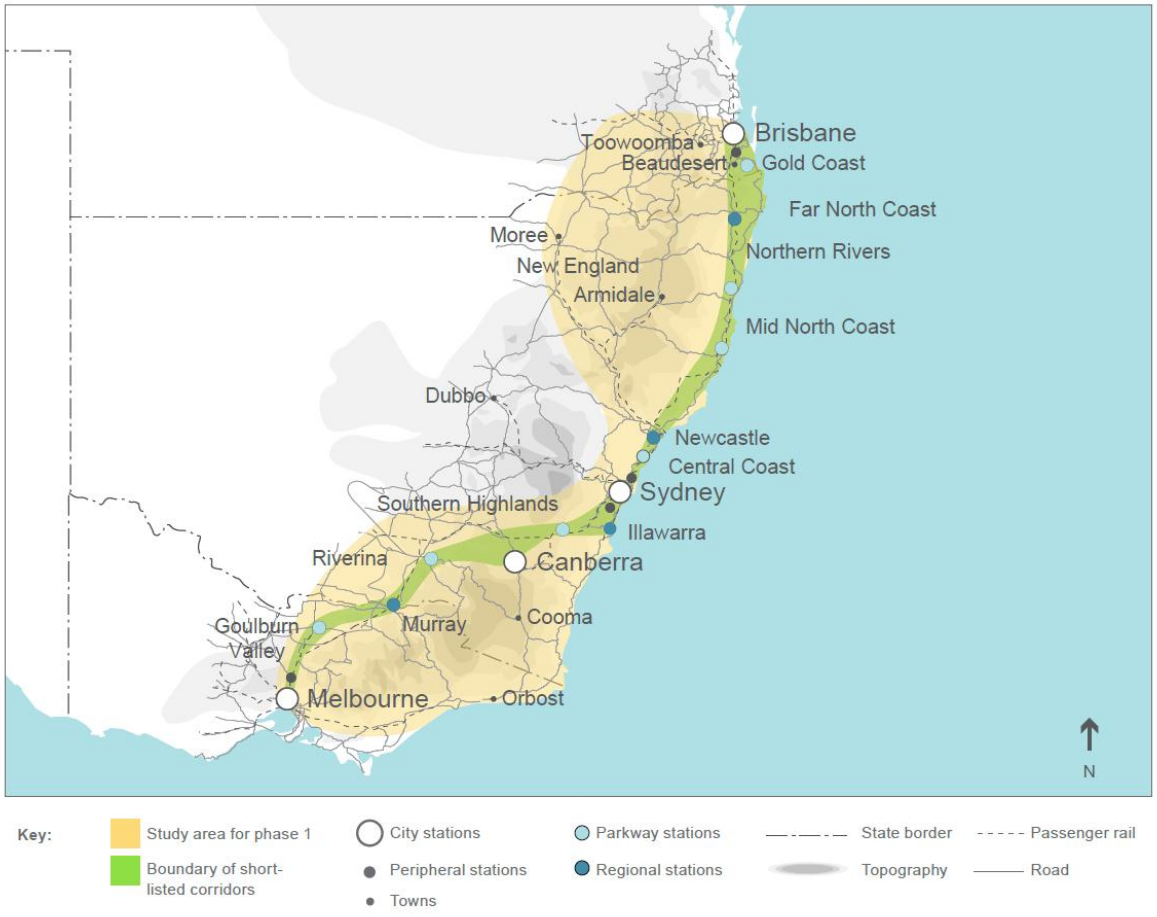
	Phase 1 Report	ARA Report	This Report
Costs	Yes	No	No
Direct Benefits			
User benefits	No	No	Yes
Operator net benefits	No	No	No
Externality benefits			
Accident benefits	No	No	Yes
Climate change benefits	No	No	Yes
Air and noise pollution benefits	No	No	Yes
Air and road congestion benefits	No	No	Yes
Agglomeration benefits	No	Yes	No

This report should *not* be considered a stand-alone report into the costs and benefits of HSR in Australia. Rather, it is a fleshing out and high level quantification of some of the benefits of HSR, particularly those pertaining to externalities such as climate change and the environment. In the Phase 2 Report these benefits will be fully quantified and compared to the costs.

2. Description of proposed HSR route and patronage

This report assumes that the HSR route and patronage are as per the recommendations of the Phase 1 Report. While some of the exact route options are still being addressed (for example, although there is only one short list corridor now being considered between Melbourne and Canberra, there are still five short listed routes between Newcastle and Brisbane), there is agreement on the general route of the HSR, as shown below (AECOM, 2011, p. iii).

Figure 1 Proposed route for HSR - inside green shaded area



Going South to North, the HSR will follow:

- The Hume Highway corridor (via Wagga-Wagga, Albury-Wodonga, Canberra and then the Southern Highlands). An option to Shepparton is also under consideration.
- The Central Coast corridor from Sydney to Newcastle.
- A coastal corridor via the Gold Coast to Brisbane.

It is the potential future market demand for HSR that drives the various benefits that are addressed in this report. Patronage for HSR can be considered in a number of ways:

i. By considering the number of trips taken between each station, called the annual patronage.
ii. By considering the passenger kilometres travelled between each station (number of passengers times distance travelled).
iii. By considering whether these trips or kilometres travelled are substituting for another form of transport (say air travel or car) or whether they are induced trips (extra trips that were taken because the HSR exists, that would not have been taken otherwise).

Table 2 below shows the assumed patronage numbers that drive the estimates in this report. These are from the Phase I Report **(AECOM, 2011, p. 41)** and are based on forecast patronage numbers in 2036, the assumed first year in which HSR is at full operational capacity.

Table 2 2036 Base HSR travel demand - thousands of trips

Origin	Destination										
	Melbourne	Reg A	Canberra	Reg B	Sydney	Reg C	Newcastle	Reg D	Gold Coast	Brisbane	Total
Melbourne		1,978	730		3,393		210		52	589	7,552
Reg A	1,978		176		239						2,393
Canberra	730	176		390	3,291	213	287		57	325	5,469
Reg B			390		1,378						1,768
Sydney	3,993	239	3291	1,378		1,905	3,116	3,848	322	1,724	19,814
Reg C			213		1,905					130	2,249
Newcastle	210		287		3,116					281	3,894
Reg D					3,848					1,709	5,557
Gold Coast	52		57		232						430
Brisbane	589		325		1,724	130	281	1,709			4,758
Total	7,552	2,393	5,469	1,768	19,814	2,249	3,894	5,557	430	4,758	53,883

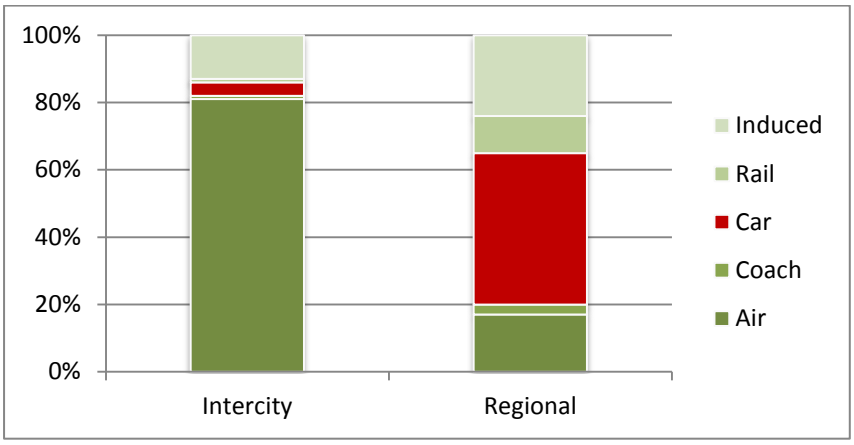
It is assumed that some 54 million trips will be taken in 2036. This number is assumed to rise to 92 million trips after 20 years (i.e. 2056), due to population growth, rising petrol prices and so on. To put this in context, in 2009-10, there were some 51 million domestic trips by air in Australia (BITRE, 2011, p. 89). From the table above, we can see the following:

- Trips to regions make up most of the HSR trips. Trips involving starting or finishing at a regional town account for about 32 million (or 60%) of the 54 million HSR trips. Trips between cities (Melbourne, Canberra, Sydney, the Gold Coast and Brisbane) account for 40% of the trips.
- The number of regional trips is likely to be understated as in the Phase 1 Report, and in this report, inter-regional trips are not included as they are assumed to have a small overall impact.

The patronage numbers shown above can be combined with the distance between each station to produce annual passenger kilometres. For 2036, this gives 22.5 billion passenger kilometres (or bpk, a standard transport and infrastructure measure). Of this 22.5 bpk, about 8.3 bpk relates to regional travel.

Finally, we need to assess where the HSR patronage comes from – i.e. what type of transport it has been substituted for. Figure 3 below shows the sources of the forecast HSR trips for 2036, based on the assumptions in the Phase 1 Report (AECOM, 2011, p. 51). The diagram makes it clear that most intercity HSR trips will be substituted from plane flights, as expected. Over 42% of regional trips are substituted car trips. A significant proportion of HSR trips are expected to be new (or induced) trips, as a result of the HSR. 24% of trips to regions (or 7.6 million trips) are new trips that would not have been made without the HSR. This in turn gives rise to significant agglomeration benefits which are discussed in Section 8 below.

Figure 2 Source of HSR patronage in 2036



These sources of HSR patronage are then combined with the passenger kilometre measures to estimate the reduction or increase in passenger kilometres travelled by each mode as a result of the introduction of HSR.

This gives the following results:

- HSR is expected to substitute for about 24% of Australia's total domestic air kilometres, meaning a significant reduction in GHG emissions from flying.
- Total car kilometres will reduce by 1.4%. While a 1.4% reduction in total car kilometres travelled may seem small, this will have a very large benefit for congestion, accident and pollution levels associated with cars on the road.
- Overall, HSR is expected to substitute for some 6% of Australia's total passenger travel needs.

This is summarised in the table below, which shows the source of the 22.5 bpk travelling by HSR.

Table 3 Impact on projected passenger kilometres travelled in 2036

Compared to 2008	Billions of passenger kilometres (bpk)	Percentage reduction from 2008 bpk actually travelled
Flights reduce by.....	14.0	24.1%
Car trips reduce by.....	3.6	1.4%
Slow rail and bus trips reduce by.....	1.2	3.6%
New trips by HSR	3.7	n/a
Total HSR passenger kilometres	22.5	6.0%

The numbers in Table 3 are a key driver of the benefits described in the rest of this report.

3. User Benefits

Getting between places has a cost to transport users, both in terms of the time taken to travel but also a loss of general comfort and safety. As the cost reduces, the benefit to consumers grows. In economic terms, this is called a change in consumer surplus.

As a result of the introduction of HSR on Australia's East Coast, there will be a change in consumer surplus. This is because, people travelling by HSR rather than car, coach or conventional travel will have:

- Much quicker travel times - meaning they save time for other activities.
- More comfortable travel – HSR trains benefit from comfortable seats, phone and internet access. Many have business conference coaches so that private meetings can be held.
- Less stress and anxiety - HSR has very high levels of departures and arrivals that are on time, combined with very high safety standards. This is a particular contrast to the delay issues plaguing Australia's very busy major airports.

The user benefits that will accrue as a result of HSR have been quantified as part of the corridor analysis for the Phase 1 Report, but the value of that benefit will not be published until the Phase 2 Report.

An order of magnitude user benefit can be calculated for HSR in the following way:

i. Estimate the number of trips that will be substituted from car, coach and conventional rail to HSR, for each origin-destination pair.
ii. Estimate the time saved for each trip by switching to HSR.
iii. Combine the time saved with a measure of the Value of Time (VoT), expressed as dollars per hour, to reach a total value of the user benefit.

Theoretically, this calculation requires that the trips taken be divided according to purpose of trip, and overall length of trip, as the Value of Time varies depending on whether someone is travelling for business (where time has a very high value) or for leisure (where people are more relaxed about time taken and so values are lower). There are also variations in exactly how much time is saved depending on whether one has switched from car to HSR or bus to HSR. However this calculation has been done at a high level, i.e.

- An overall VoT has been assumed at $20.50 per hour. This is the assumed VoT from the Phase 1 Report for 'long regional, leisure trips' (AECOM, 2011, p. C6). It is a conservative estimate of the measure of user benefits, as it is lower than the overall average VoT ($34.10) and much lower than the business trip VoT (about $65 per hour).
- Time savings for all travel modes are assumed to be close to the time savings for car trips. This is a little conservative for bus trips and high for train trips. It assumes, for example, that road travellers between Newcastle and Sydney will save 72 minutes in each direction.
- Those switching from air travel to HSR are assumed to derive no user benefits. This is conservative, as clearly those choosing to switch from air travel to HSR believe that they derive some benefit from HSR or otherwise they would not switch. However as total door to door travel time may be similar between HSR and flying, but with greater comfort and certainty from HSR, the user benefits from air to HSR switches are not amenable to this time-based method.
- Induced HSR trips (i.e. trips that would not have happened without HSR) are valued at half the generalised reduction in travel cost for other modes. This is the same approach adopted in the Phase 1 Report.

This can be illustrated for the Melbourne to Canberra trip, as follows:

i. *The Phase 1 Report assumes that 730,000 trips will be made from Melbourne to Canberra by HSR each year. Of these trips, our model, described in Section 2, estimates that 45,000 of these trips are switches from road, bus or train travel, 95,000 trips are induced (new) HSR trips and 590,000 are switched from air travel.*
ii. *We then estimate a user benefit for the 45,000 trips that switch from road, bus or train to HSR. Each of these trips is estimated to save about 5hours, 20 minutes, CBD to CBD. Valuing this time at $20.50 gives a total user benefit per trip of $109.*
iii. *Applying this $109 to all of the 45,000 road trips, and half of the 95,000 induced trips, gives a total user benefit for HST trips from Melbourne to Canberra of $9.98 million per annum.*

This approach gives total user benefits in the order of $1.34 billion per annum. Valuing this over a thirty year period, with a discount factor of 7% and increasing assumed HSR volumes as per the Phase 1 Report, gives a total value of $31 billion over the first 30 years. This may be conservative, but gives an order of magnitude for how significant the user benefits from HSR will be.

4. Accident Benefits

In the previous section, we noted that HSR is expected to substitute for 3.6 billion passenger kilometres of car travel. The costs to society of car travel are well understood and include:

- noise and air pollution
- greenhouse gas emissions
- traffic congestion
- high costs associated with road maintenance and building.

However the greatest cost to society from our car use is less well understood. This is the cost arising from the very large number of injuries and deaths occurring from road traffic each year. Costs associated with car accidents can be partly met by private insurance, however the larger costs concern:

- lifetime medical and administration costs; and
- loss of productivity, utility andhappiness.

The total cost of passenger vehicle accidents in Australia in 2006 has been estimated at between $17.2 billion (BITRE, 2009) and $28 billion (Deloitte, 2011), depending on what value is placed on a statistical life.

The Phase 1 Report estimated accident externality costs for the purpose of comparing alternative HSR corridors. It is recognised in the industry that HSR is safer than conventional rail, so the accident cost for HSR was assumed to be a third of that for conventional rail. Other externality costs were adopted from well established European accident costs, adjusted for Australian specific factors such as higher car occupancy rates and lower population density. These are summarised below, for each mode of travel.

Table 4 Accident externality costs in 2036 (June 2011 prices per 1,000 passenger kilometres)

	Car	Coach	Rail	HSR	Air
Cost	$74.0	$5.2	$4.5	$1.5	$1.4

High speed rail is expected to have a safety level close to flying, and just 2% the accident cost of car driving. For every 1,000 kilometres travelled on Australian roads, the cost to society of accidents is $74. By contrast, the cost of travelling by HSR would be only $1.50 per 1,000 passenger kilometres.

Applying these externality costs to the HSR volumes and sources listed in Table 3 above, we can estimate that the annual reduction in the cost of accidents in Australia would commence at $260 million per annum. Valuing this over a thirty year period, with a discount factor of 7% and increasing assumed HSR volumes as per the Phase 1 Report, gives a total value of accidents avoided of $4.2 billion.

This estimate is consistent with the comparative accident cost generated by Deloitte Access Economics in its recent paper *The True Value of Rail*. This report estimated that every 1,000 passenger kilometres taken by (conventional) rail rather than by road saved $81.90 (Deloitte, 2011, p. 36), slightly higher than the difference of $69.50 in Table 4 above.

5. Climate change benefits

The impact of varying forms of transport on greenhouse gas (GHG) emissions can be assessed directly by comparing CO_2 emissions per 1,000 passenger kilometres for each different transport mode. The volume of emissions is then combined with a carbon cost to give an externality rate for GHG emissions.

This has been done as part of the corridor comparison in the Phase 1 Report. The key assumptions underlying the climate change externality are:

- A carbon cost of $34 per tonne of CO_2 rising to $107 per tonne in 2036 and then continuing to rise subsequently. Note that, as we are pricing externalities, the market traded price of carbon need not constrain us, as we are trying to estimate the true cost to society (of the underlying climate change associated with GHG emissions) rather than the traded value of carbon credits.
- Electricity is assumed to be sourced from the National Grid, but with the mix of electricity assumed to change towards renewable such that by 2020 Australia's GHG emissions are 15% lower than the 2000 level.
- Car, coach and air have been assumed to improve fuel efficiency by 0.5 per cent per annum.

These assumptions give the following climate change externality rates.

Table 5 Climate change externality costs in 2036 (June 2011 prices per 1,000 passenger kilometres)

	Car	Coach	Rail	HSR	Air
Cost	$10.9	$2.6	$4.8	$3.1	$11.5

Flying has the highest impact on climate change, per kilometre travelled. Car travel, is however, not far behind. Travelling by HSR reduces climate change costs by almost 75% compared to flying and by 70% compared to driving.

Applying these externality costs to the HSR volumes and sources listed in Table 5 above, we can estimate that the annual reduction in the cost of GHG emissions in Australia would commence at $140 million per annum. Valuing this over a thirty year period, with a discount factor of 7% and increasing assumed HSR volumes as per the Phase 1 Report, gives a total value of GHG emissions avoided of $2.2 billion.

These costs mean that HSR is expected to reduce net GHG emissions by some 1.3 million tonnes of CO_2 emissions in its first year of operation, of which about 1.1 million tonnes relates to avoided airplane flights and 0.2 million tonnes relates to avoided car journeys. That's the equivalent of taking 365,000 cars off the road. The carbon saving will rise over time as HSR passenger volumes increase.

These GHG costs can be compared with estimates in the Deloitte True Value of Rail Report to assess reasonableness. The Deloitte GHG estimated costs are lower, at about $1.20 difference between car and conventional rail per 1000 passenger kilometres (compared to $6.10 in Table 4 above). The reason is that the Deloitte estimate is based on 2010 costs, when the carbon price is assumed to be $26.70 per tonne (Deloitte, 2011, p. 29), as opposed to this report which is based on a 2036 carbon price of some $107, as per the Phase 1 Report. Adjusting for this difference gives a reasonable fit to the Deloitte estimate.

6. Air and noise pollution

This is the externality with the smallest cost, but is still worth considering as HSR offers a significant improvement in this area. Petrol and diesel emissions can have powerful and permanent negative effects on local air quality. This in turn has adverse health impacts on people living in the area, with impacts ranging from increased asthma to serious respiratory and cardiovascular disease. Car pollution can also cause environmental and crop damage.

Noise pollution is more often associated with planes but can also be caused by cars, truck and train noise. At its least serious, it is an annoyance factor that people try to avoid. However, the seriousness of noise pollution at high levels (as seen when the Sydney airport runway was extended) is great, including health impacts such as deafness, lack of sleep and mental illness.

The Phase 1 Report used air and noise pollution externality rates derived from European Union studies, adjusted for lower Australian population densities. Note that in Australia, the majority of the HSR track will pass through rural areas where few people live. However there will be some noise pollution for people living near the track when it comes into towns and this has been allowed for. Air pollution is assumed to be nil for HSR as it is powered by electricity so there is no local air pollution.

The table below summarises the Phase 1 Report externalities.

Table 6 Air and noise pollution externality costs in 2036 (June 2011 prices per 1,000 passenger kilometres)

	Car	Coach	Rail	HSR	Air
Cost	$0.7	$0.7	$0.9	$0.1	$0.2

Surprisingly, rail has the highest assumed air and noise pollution cost. This is because much of Australia's current train stock is highly polluting, and because these figures include the many urban stations and tracks that are located near large populations. Flying has much lower noise costs than might be assumed, because externality rates are spread across the entire population. This means the extreme discomfort felt by the minority who live under a flight path is not reflected in the national averages.

Applying these externality costs to the HSR volumes and sources listed in Table 3, we can estimate that the annual reduction in the cost of air and noise pollution in Australia would commence at $4 million per annum. Valuing this over a thirty year period, with a discount factor of 7% and increasing assumed HSR volumes as per the Phase 1 Report, gives a total value of pollution avoided of $64 million.

The cost of air and noise pollution was not estimated in the Deloitte True Value of Rail report and so cannot be used as a cross check on the reasonableness of this estimate.

7. Decongestion benefits

Road decongestion

As a result of some 3.6 billion passenger kilometres being diverted from car trips to HSR trips, the roads between towns serviced by HSR will become less congested. This decongestion benefit can be converted into a monetary benefit by:

- calculating the marginal change in speed able to be travelled by remaining cars on the road; and then
- multiplying this with a value of travel time factor

to give a decongestion benefit to each passenger kilometre applied to all remaining road users.

This analysis has been done in the Phase 1 Report, using a marginal speed change for all other road users of .001 minutes per kilometre travelled as a result of the introduction of HSR and a value of travel time factor of $15.00 per passenger hour (AECOM, 2011, p. C13). This results in a decongestion saving following the introduction of HSR of some .0252 cents per passenger kilometre.

This rate has been applied to the number of passenger kilometres driven by all remaining road users, some 262.5 billion passenger kilometres. This gives an annual total decongestion benefit of some $66 million or some $1.1 billion over 30 years.

The Deloitte True Value of Rail report has taken a similar approach to estimating decongestion benefits, but has instead based the benefit on a city-by-city benefit per car trip substituted to rail. Applying the Deloitte estimates for the three capital cities, to the expected number of HSR trips commencing in each city, gives the following annual decongestion benefit.

Table 7 Decongestion estimate using Deloitte capital city benefit factors.

	Number of car trips switched to HSR, starting or finishing in each capital city	Congestion cost per journey (Deloitte) dollars 2010	Estimated annual decongestion benefit, 2010 million dollars
Melbourne	2,230,000	$5.18	$11.5
Sydney	6,630,000	$7.01	$53.5
Brisbane	1,890,000	$1.84	$3.5
Total	11,740,000		$68.5

This method estimates a decongestion saving of some $68 million per annum, close to the $66 million estimate above.

Air decongestion

In March 2012 the Australian Government released its Joint Study into Aviation Capacity for the Sydney Region (Trans, 2012). The report describes the enormous increase in flight numbers expected at Sydney Airport over the next 20 years. Even on conservative forecasts, unconstrained demand is expected to more than double to 76.8 million passenger movements by 2035.

However capacity at Sydney Airport is very much constrained and this constraint is expected to have high costs. To put the congestion at Sydney Airport into perspective, the Joint Study notes that:

- By 2013, the current 8 trains per hour (from the airport) will be full with no seats available for airport passengers during the morning peak, and even with an expansion to 12 trains per hour, the trains will be at capacity by 2018.

- By 2015, capacity at the existing road intersections at the entries to the airport will be exceeded, with traffic queues of 3km (international) and 4kms (domestic); and, by 2023, there will be a "near constant traffic jam on all key roads around the airport".
- By 2020, there will be no slots available outside 6am – 12noon and between 4-7pm, and none at all by 2027.

The Joint Study estimated that the constraints imposed by congestion at Sydney Airport, if not solved through a second airport or some other solution, will lower the Australian GDP by $2.5 billion per annum by 2035. It estimates the cost of building a second airport to be in the range $8 billion to $11 billion.

The Joint Study goes on to state that HSR will not be a solution to the crisis at Sydney Airport, without expanding on its reasoning. In relation to Canberra Airport, it says:

> *Canberra Airport is an important airport with infrastructure capable of handling the full range of services,* ***but is not located close enough to the Sydney market to take the role of Sydney's second RPT airport****. It will serve a growing RPT market in southern NSW and will provide an additional option for a small proportion of Sydney passengers who are prepared to travel the extra distance.*
>
> *Canberra Airport is the only curfew-free airport within reach of Sydney and provides the potential for night-time services which cannot be accommodated in Sydney, in particular international LCC services and overnight freight services. It is important that Canberra's 24 hour unrestricted curfew-free status be protected.* (Trans, 2012, p. 27)

Since the release of the Joint Study, Canberra Airport has released a plan for a $140 million HSR facility to be constructed adjacent to the new airport terminal[2]. The purpose of fast-tracking construction of this part of the HSR network would be to divert significant volumes of air-traffic from Sydney Airport to Canberra by 2020, with passengers connecting to a 57 minute HSR trip to the Sydney CBD.

The cost of the portion of the HSR between Canberra and Sydney – estimated at about $15 billion – is comparable with the costs of a second Sydney airport, at about $10 billion.

Given that HSR intercity routes are, first and foremost, a substitute for air travel, it is interesting that the Joint Study does not consider the possible impact of HSR on future domestic flight demand. In Section 2 we estimated that some 22.7 million passenger trips will be diverted from Sydney Airport to HSR in 2036. This represents 63% of the 36 million actual passenger trips at Sydney Airport in 2010-11 and 30% of the forecast 76.8 million passenger trips at Sydney Airport in 2035. HSR can thus serve two purposes in regard to Sydney Airport:

- Substitute for 30% of forecast 2036 passenger trips; and
- Transport people to Canberra Airport from where they can fly to their final destination. The *Joint Study* found there were 2.5 million domestic passenger connections through Sydney Airport. These hobbing passengers represent about 10% of the domestic demand, all of which could be serviced through Canberra Airport in the future.

HSR could thus meet up to 40% of future Sydney Airport passenger demand. This is borne out by experience overseas – the table below shows the percentage share that HSR has taken from air trips in some HSR voyages with similar HSR in-train durations (AECOM, 2011, p. B23).

[2] Canberra Airport media release 12 June 2012.

Table 8 Consistency of intercity HSR air share assumptions against international experience

HSR Journey	Trip time Hr:Min	HSR mode share	HSR Journey	Trip time Hr:Min	HSR mode share
Madrid-Seville	2:30	86%	London-Manchester	2:20	60%
London-Paris	2:45	70%	Milan-Rome	4:20	38%
Paris-Marseilles	3:05	68%	***Sydney-Melbourne***	***2:37***	***55%*** *assumed*

The assumption of 55% HSR mode share on Sydney-Melbourne may be conservative when compared with Madrid-Seville or London-Paris lines with very similar trip times and HSR mode shares above 70%.

The Phase 1 Report does not include any air travel decongestion benefits in its discussion of HSR benefits, and explicitly *excludes* the issue of congestion at Sydney Airport on the grounds that 'It is likely that airport congestion ... at Sydney Airport ... will need to be addressed sooner than 2036. Given this assumption, no air traffic decongestion benefits were included in the calculations'

This report assumes a net present value of the air decongestion saving as $10 billion, equivalent to the avoided cost of a second Sydney airport.

8. Agglomeration benefits - bringing people together

HSR brings people together in a faster and more comfortable way, both for leisure and for business purposes. The direct benefit for consumers who are travelling, in terms of travel time savings and comfort, has already been quantified in Section 3.

However there is evidence that, by bringing regions and towns closer, HSR also has wider and more indirect economic and social benefits. This is because as a result of greater connectivity offered by HSR, there is:

- improved access to jobs (including improved access to particular locations for work-related activities); and
- a reduction in social exclusion consequent on increased potential accessibility to activities (additional to jobs).

These benefits are called 'agglomeration' benefits and are generally expressed as a proportion of real gross domestic product (GDP), in the case of economic benefits; and as a proportion of total household income, in the case of social benefits. Many studies now point to agglomeration benefits as one of the strongest economic arguments in favour of HSR. A recent report into HSR in the US suggests that, "[t]he magnitude of agglomeration economies is uncertain (and certainly location-specific), but I think presents the best case that can be made in favor of HSR in the US."[3]

A recent report by the Institute of Transport and Logistics Studies (ITL) has estimated the value of the agglomeration benefits from HSR in relation to the Sydney-Melbourne leg of the trip (Hensher, 2012). This involved building a complex model, at the local government level, of HSR impacts on productivity elasticity and other economic measures. This report had the following conclusions:

i. The potential order of magnitude for the employment-related agglomeration benefit is quite small. This is because of the very long distances between stations in Australia (compared to, say, the UK) meaning that the creation of employment hubs or super-regions is limited. The ITL estimates this benefit (for the region from Canberra to Melbourne) as $20 million per annum for work-related travel (Hensher, 2012, p. 33).
ii. The potential order of magnitude for the social agglomeration benefit is very high. This is because HSR greatly improves social density for those living in regional areas and their ability to connect with each other and also with those living in towns. The flow on benefits to tourism, sports and arts are likely to be high. The ITL estimates this social benefit as up to $4.2 billion per annum, or 1.3% of Total Household Income.

Social agglomeration or connectivity benefits thus potentially provide a very broad economic impact from HSR. It is beyond the scope of this paper to extend the ITL analysis to the whole HSR route, or to confirm its findings, however its findings are included here as an important addition to the direct user benefits described in the preceding sections.

[3] Levinson, D. (2012) Accessibility impacts of high-speed rail: Viewpoint, *Journal of Transport Geography* (in press online)

9. Case Study 1 – Benefits for Melbourne

Melbourne is a city that is growing fast. Its current population is over four million, but this is expected to reach five million by the first year of operation of the HSR and exceed six million by 2050. Melbourne's outer suburbs in particular are growing faster than any other area in Australia, part of a record-breaking trend that has seen Melbourne's population is closing the gap on Sydney. Since 2001, Melbourne has gained 605,000 new residents, up 17 per cent, rapidly pushing out the urban boundary in every growth corridor.

Like many fast growing cities, Melbourne suffers from infrastructure, housing affordability, traffic congestion and pollution problems. It also faces enormous pressure on land available for development. In 2009-10, based on ABS estimates, roughly 68 per cent of the city's new people settled more than 20 kilometres from the GPO. That was a sharp rise from 58 per cent over the previous three years.

HSR is a powerful way to address these problems. Before discussing this, we first describe the proposed Melbourne HSR in more detail.

From Southern Cross Station, the HSR will travel about 20km north to a Northern peripheral station (probably at Craigieburn). The first 18 kilometres will be in a tunnel. (Note that Beveridge is also being considered as a possible second peripheral station, because of its location on the proposed Outer Orbital Road). From there, the HSR will continue on to Albury-Wodonga (with a potential deviation to Shepparton) and Wagga Wagga, before reaching Canberra airport.

In its first full year of operation, HSR is expected to transport some 15 million people in or out of Southern Cross Station[4]. To put this in context, about 26 million domestic and international trips are made to and from Melbourne Airport each year (BITRE, 2011, p. 90). Nearly 4 million of these 15 million trips will be to and from regional areas in Victoria and Southern NSW. Melburnians will be able to travel by HSR to the following places in the following times:

Table 9 Travel times from Melbourne by HSR

From Southern Cross Station to....	Time
Shepparton	55 minutes
Albury-Wodonga	1 hour 5 minutes
Wagga Wagga	1 hour 25 minutes
Canberra	1 hour 50 minutes
Sydney	2 hours 40 minutes

There are expected to be 29 daily one way intercity services on the Melbourne-Canberra leg of the HSR, along with 18 daily one-way trips to regional areas (AECOM, 2011, p. F3).

The benefits described in the preceding sections can be estimated for the people of Melbourne. If we look only at trips *originating* in Melbourne, the HSR will deliver:

[4] Note that North Melbourne is still a short listed option for the Melbourne HSR station but the analysis appears to favour Southern Cross Station.

- Travel time savings valued at nearly $200 million and equivalent to some 565 million minutes or 140 minutes saved per annum for each of Melbourne's 4 million residents.
- A reduction of 9.8 million passenger trips in and out of Melbourne Airport in 2036. To put this in context, in 2009-10 there were 26 million passenger movements at Melbourne Airport. This significant shift to HSR will have significant beneficial effects, not only on airport congestion but also traffic congestion on the Tullamarine freeway.
- A reduction in accident costs for Melburnians of $30 million per annum. This is the accident externality saving relating to all HSR trips originating in Melbourne. Getting cars off Melbourne's busy roads and people into HSR will save lives.

In addition to these monetary benefits, HSR will have enormous beneficial impacts on Melbourne's struggling first home buyers and commuters. HSR users will be able to live in Albury or Shepparton and commute on a daily basis to the Melbourne CBD. This will take pressure off Melbourne's straining outer suburbs while also boosting regional economies. Perhaps more importantly, it will help get people into the property market by enabling them to buy property in regional Australia while commuting to where the jobs are.

Melbourne already has three major rail projects being built or under consideration, all of which could integrate powerfully with HSR:

- The $4.3 billion Melbourne Regional Rail Link, due to be completed in 2016, provides for substantial increases in capacity and reliability for Geelong, Ballarat and Bendigo regional rail services. Once completed, trains from these regional centres will be able to operate into Melbourne without being delayed behind suburban trains. The project will also free up capacity for extra suburban services from Werribee, Sunbury and Craigieburn along Melbourne's western growth corridor. The Regional Rail Link would connect Geelong to the HSR network at Southern Cross, providing a powerful extension of the reach of HSR.
- The Baillieu government has committed $50 million on preliminary works to build a railway line to Avalon, planned as Melbourne's second airport over the long term.
- Melbourne Airport Rail Link, being planned to increase public transport capacity between Melbourne CBD and Melbourne (Tullamarine) Airport, is still under consideration. A two year Feasibility Study is currently being undertaken into this link.

In addition the final HSR route could include the Melbourne (Tullamarine) Airport. Consideration would need to be given to the viability of such a route including impacts on inter-city travel times and construction costs. We understand this will be examined in the Phase 2 study.

10. Case Study 2 – Regional benefits between Melbourne and Canberra

The current short listed HSR route north of Melbourne goes through Albury-Wodonga and Wagga Wagga, with "potential deviations toward Shepparton". The significance of all three towns to the regional and economic benefits associated with HSR was highlighted in the Phase I Report. This section illustrates how regional towns like Shepparton, Albury and Wagga would benefit from HSR.

As a result of their isolation and limited economic benefits, regional towns frequently suffer from a variety of socio-economic disadvantages. Consider how the three regional towns on the proposed HSR route from Melbourne to Canberra fare on the SEIFA index of disadvantage. This index, maintained by the ABS, is derived from attributes such as low income, low educational attainment, high unemployment, jobs in relatively unskilled occupations and variables that reflect disadvantage. A score of less than 875 on the SEIFA Index means that the population are in the lowest socio-economic decile for Australia.

Table 10 Relative disadvantage along HSR Melbourne - Canberra route: the SEIFA index

	Population with SEIFA score < 875	Population		Population with SEIFA score < 875	Population
Greater Shepparton	17%	57,000	**Wagga Wagga**	13%	56,000
Albury	12%	46,000	**All Victoria**	6%	4,906,000
Wodonga	14%	33,000	**All Australia**	9%	19,608,000

The regional towns along the proposed HSR route have high indices of socioeconomic disadvantage. Between 12% and 17% of the population is disadvantaged, compared to 6% for all of Victoria and 9% in all of Australia. These are the types of communities who stand to benefit from increased access to employment opportunities as well as health and welfare services. HSR also offers the possibility of regional rebalancing along the route, by bringing a greater proportion of people with greater skills and opportunities in to these communities.

Addressing the problem of relative social disadvantage has been a key driver of HSR in many countries. In the UK, regional 'rebalancing' has been a key driver of the HS2 high speed rail linking London to the North. The premise is that HSR will lead to "*strategic change in the economic geography of Britain, supporting sustainable long-term growth and reducing regional disparities*" (DFT, 2011). The experience to date is that HSR has supported the growth opportunities in regional areas, provided that HSR is supported by appropriate local measures (Wenban-Smith, 2009).

Regional towns close to an HSR station can be expected to benefit in a number of ways:

- Because of HSR, there will be a significant increase in visitor numbers, both for tourism and for work purposes, to the regional centres along the HSR line. The modelling estimates that some 7.6 million additional trips will be made to and from regional areas that would not otherwise have occurred. Of these, 1.15 million trips are new trips to Wagga, Albury-Wodonga and Shepparton. The economic benefit of these additional trips will be significant for the regions affected, both through tourism income but also through increased work options.
- HSR opens the door for Australians to live in regional areas and commute to cities for work. Regions die because of the lack of accessible employment within commuting distance, not because people do not enjoy the lifestyle. HSR would mean that someone living in Albury could commute to the Melbourne CBD in one hour and 5 minutes. Someone living in Wagga

could commute to Canberra in less than half an hour. It is these opportunities that contribute to the regional rebalancing goal that is driving much of Europe's HSR expansion.

- The economic opportunity from bringing cities closer to regions can be considered if we look at rental rates in different cities. The table below shows median rents for a three bedroom house during the March 2012 quarter for some of the areas under consideration:

Table 11 Median rents 2012 Q1 Victorian LGA

Local government area	Median rent	Local government area	Median rent
Greater Shepparton	$250	Melbourne	$588
Wodonga	$277	Total Metro	$340

The opportunity for regional rebalancing is clear – households can reduce their weekly rent by $90 a week by moving from metropolitan Melbourne to Shepparton, but still only have a 50 minute commute to work. Such an opportunity both eases the cost of living for families in the short term but also longer term can have a positive uplift on depressed regional house prices.

HSR also expands the role of major social and business enterprises in regional areas. Consider for, example, hospitals, universities and businesses in Wagga Wagga and Albury-Wodonga.

- ***Hospitals.*** The Albury-Wodonga hospital is the single largest centre for hospital health care facilities in the Riverina region, while Wagga Wagga is a major medical centre with a full teaching hospital and clinical centre. HSR will mean that a large portion of UNSW medical students will be able to undertake their clinical training in Wagga Wagga and the Riverina area, as well as allowing greater sharing and improved patient care between the major hospitals in NSW and Victoria.
- ***Universities.*** HSR will provide access to the two universities at Albury-Wodonga (La Trobe University Albury-Wodonga campus and Charles Sturt University Thurgoona campus) and at Wagga Wagga (the Charles Sturt University campus specialising in agricultural sciences and horticulture). This means that the economic viability of these campuses will be strengthened, because students can commute from further away and also the local catchment for students will increase as more families relocate to the regional centres.
- ***Businesses.*** Over time, companies have the chance to reduce costs by relocating to regional Australia, rather than off-shore, as they will be able to attract employees from a much great catchment area. The freight possibilities for HSR have not been addressed in this paper as the focus is on passenger movements, but for certain high value low volumes products, such as fresh vegetables, there is an opportunity to increase businesses access to high value customers in cities. This is clearly the case for towns such as Shepparton and Wagga which have grown on the back of agricultural products.

The regional rebalancing benefits of HSR are clearly extremely broad and wide-ranging. They have not been quantified in this paper but should be considered as part of the Government's detailed Phase 2 Report.

11. Conclusion

This report has placed indicative values on some of the benefits from HSR that were not included in the published Phase 1 Report into HSR. The magnitude of benefits to users, society and the environment is found to be very significant. The biggest contributor to this is the time savings that travellers will be able to make, particularly commuters from areas such as Newcastle and Canberra. Regional Australians will also make considerable time savings. However the benefits to non-HSR users, including road and air decongestion, as well as reduced GHG emissions, are also in the billions of dollars. The saving in accident costs, valued at some $4 billion, is a benefit that is almost unquantifiable for those affected.

Figure 3 Some benefits of HSR, valued over thirty years of operation

Quantified Benefits	
$31 billion	Time savings
$2 billion	Greenhouse gas savings
$11 billion	Congestion savings
$4 billion	Accident savings
$64 million	Pollution savings
$48.064 billion	**Total Benefits**

This report has identified some $48 billion of benefits from HSR, including direct user benefits and also externalities to society. There are other benefits from HSR that are beyond the scope of this report, including:

1. Operator benefits – this is the net profit that operators of the HSR will make from the surplus of user charges over costs. However offsetting this, is a loss of net revenues to operators of other transport modes which HSR would substitute for.
2. Agglomeration benefits – this is the economic and social benefit from reducing effective distances between firms, individuals and communities. A report commissioned for the ARA has estimated these benefits at some $4 billion per annum.
3. Freight transport benefits. Many freight routes in Australia currently suffer from bottlenecks, particularly rail freight. HSR will help to address this both by freeing space on conventional trains, by taking much of the passenger burden, and also by performing freight task movements, particularly at night.

There are also certain direct and indirect costs involved with HSR that are not addressed in this report or quantified in the Phase 1 Report, including a potential reduction in fuel excise duty to the government because of lower fuel consumption by road vehicles and aircraft.

As a nation-building project, HSR will position Australia well for the population growth being forecast by the ABS, as well as for a carbon constrained world. This report shows that the direct user benefits and the externality benefits make up over half of the forecast cost to build HSR. HSR is therefore worthy of serious consideration and analysis. A full analysis and public quantification of direct and indirect economic, social and environmental benefits is an important priority for government.

Works Cited

AECOM. (2011). *High Speed Rail Study - Phase 1.* Canberra: Department of Infrastructure and Transport.

BITRE. (2009). *Cost of Road Crashes in Australia 2006, research Report 118.* Canberra ACT: Bureau of Infrastructure, Transport and Regional Economics.

BITRE. (2011). *Australian Infrastructure Statistics Yearbook 2011.* Canberra, ACT.

Deloitte, A. E. (2011). *The True Value of Rail.* Sydney.

DFT, D. f. (2011). *High Speed Rail: Investing in Britain's Future Consultation.* London: UK Department for Transport.

Hensher, D. e. (2012). *Assessing the wider economy and social impacts of high speed rail in Australia.* Sydney: Australasian Rail Association.

Trans, D. I. (2012). *Joint Study into Aviation Capacity for the Sydney Region.* Australian Government.

Wenban-Smith, A. (2009). *Complementary measures to facilitate regional benefits from High Speed Rail.* Birmingham: Greenguage21.